

Chapter 3

The OSGI SIB: A Resilient Semantic Solution for the Internet of Things

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ABSTRACT

The research activity in the IoT field caused a proliferation of information brokers with different features and targeted at different information abstraction levels. The OSGI Semantic Information Broker (SIB) is a portable and extendable solution for providing an IoT system with semantic support, a publish subscribe paradigm, and expressive primitives for information modeling. In this chapter the authors explain the main reasons for defining a new SIB version, substituting the previously used RedSIB, its main features and comparative evaluation against both ad hoc and standard benchmarks. Furthermore, recently defined primitives and experimental work on the portability to mobile devices and resiliency are proposed and discussed.

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INTRODUCTION

This chapter extends the work proposed in (D’Elia, Viola, Roffia, Azzoni, & Cinotti, 2017) about the implementation of a OSGI-based semantic information broker (SIB) and the comparison with the “red SIB”, the previous SIB implementation inspired by M3(Ovaska, Cinotti & Toninelli, 2012) technology. The OSGI SIB has been extended with further functionalities (D’Elia, Aguzzi et al., 2017) focused on the dependability and on the resiliency to abrupt client disconnections.

The interest on Semantic Web technologies applied to the Internet of Things (IoT) (Barnaghi, Wang, Henson, & Taylor, 2012; Kovatsch, Hassan & Mayer, 2015) has been the main topic of several international research projects and academic research activities, aimed at improving IoT solutions with semantic technologies. The Semantic Web was conceived to change the Web and drive it towards the original vision that Tim Berners Lee had in mind: a web of data (Berners-Lee, Hendler, Lassila et al., 2001). Semantic Web technologies allow to represent (i.e., RDF - Resource Description Framework, <http://www.w3.org/RDF/>, OWL - Web Ontology Language Reference, W3C Recommendation, 10 February 2004, <http://www.w3.org/TR/owl-ref/>) and retrieve (i.e., SPARQL - SPARQL 1.1 Overview W3C Recommendation 21 March 2013, <http://www.w3.org/TR/sparql11-overview/>) semantically enriched information, thus they have a high level of generality and inter-disciplinarity. One of the most interesting field of application is that of collaborative agents offering advanced services for private users and enterprises. The Semantic Web also applies to classification, abstraction, mining and reasoning over large amount of data. Information about energy consumption, user profiles, environmental monitoring, financial data and other similar data sources can be analyzed by smart software agents and used to perform context-aware operations (where context can be defined as “any information that can be used to characterize the situation of an entity, where an entity can be a person, a place or physical or computational object” (Abowd et al., 1999)).

In 2008, the ARTEMIS joint undertaking funded the FP7 European Project SOFIA (Smart Objects for Intelligent Applications) to develop a platform for sharing semantic information for the widest possible range of devices and agents. Since the conclusion of SOFIA, the platform has been adopted, evaluated and extended in several European research projects (e.g., CHIRON, IoE, RECOCAPE, IMPRESS, ARROWHEAD, CONNECT) in partnership with industrial players. Some of these projects are still ongoing and new projects proposals are currently in preparation to continue from the previous results. The multipurpose architecture conceived in SOFIA and called Smart-M3 represents one of the most important attempt to adopt the Semantic Web in IoT (smart environments) and has become one of the European reference platforms mentioned in the IoT oriented call for proposals. Smart-M3 follows a publish-subscribe model and proposes a simple approach based on two components and their communication protocol (Figure 1). The Semantic Information Broker (SIB) stores and shares the semantic information that is exchanged by smart objects of the Smart-M3 ecosystem. KPs (Knowledge Processors) run in the smart objects, process the information, update it, query the SIB and subscribe to the information stored in the SIB to be always up to date. KPs communicate with the SIB through the SSAP protocol (Smart Space Access Protocol). The SIB is not bound to a specific implementation and it is generally intended as a software able to read, process and produce SSAP messages, while coherently managing the semantic knowledge base (KB) stored in the SIB itself. As shown in Figure 1, the SIB can be seen as a wrapper over a SPARQL endpoint to enable the publish-subscribe mechanism.

The Smart-M3 architecture has been used in many heterogeneous application domains, and the growing interest of the community brought to the development of SIB versions more performant and featured than

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